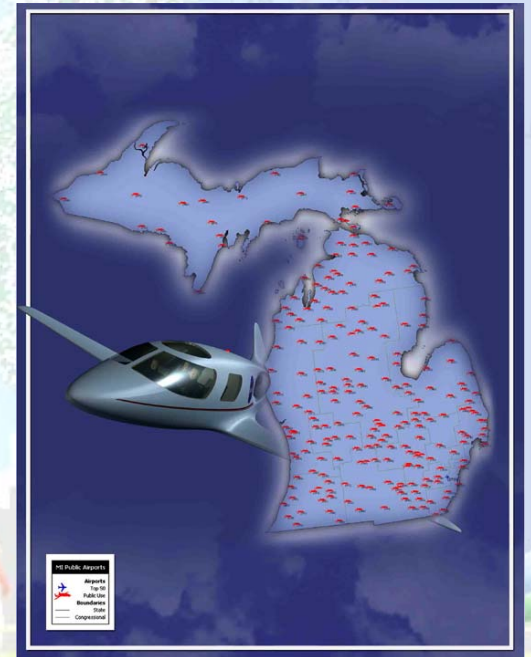


February 13, 2003



Outline

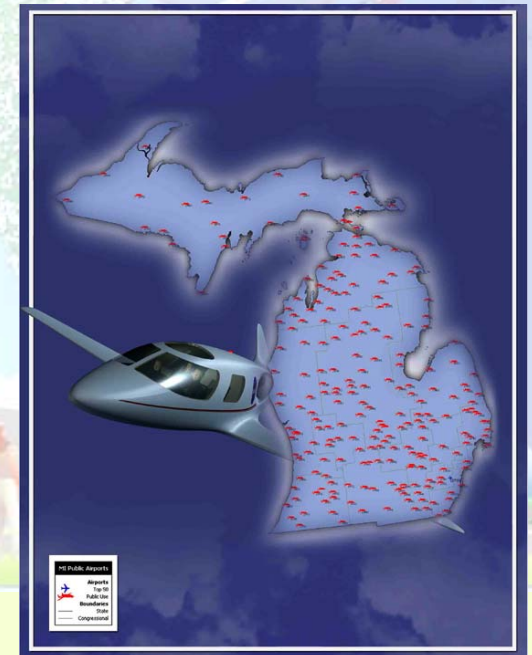
- **Studies reveal the cost and service thresholds for on-demand, widely distributed air travel alternatives to hub-and-spoke and highway travel.**
- **While we cannot know exactly what forms of travel services consumers will see, NASA's aviation technology strategies assume a “dual state” for 21st Century air travel:
On-demand distributed + hubbing services**
- **The effects on airports include:**
 - **New operational capabilities at more runway ends**
 - **Alternatives to traditional terrestrial communication, navigation, and surveillance systems**
 - **Increased demand for information-technology services**
 - **Potential for increased operations at smaller airports in the longer-term**





Innovations Affecting 21st Century Airports

- **All-Digital Cockpit Systems**
- **Airborne Internet**
- **Airport Management Device**
- **Non-towered airports procedures**
- **No-radar operations**
- **No traditional terrestrial navaids**
- **Airport Databus**
- **Land Use Efficiencies**
- **Runway Use Efficiencies**





Technical Context for Mobility Alternatives

- Moore's Law on microprocessor performance
- Gilder's Law on bandwidth performance
- Metcalf's Law on network performance
- The unwritten law of abundance
- The unwritten rule of gridlock
- Kurzweil's Law of Accelerating Returns
- The Golden Rule of the information age



The NASA Mission

*To understand and protect our home planet
To explore the Universe and search for life
To inspire the next generation of explorers*

... as only NASA can.

5

The graphic is a collage titled 'NASA Aeronautics Blueprint' with the subtitle 'Toward A Bold New Era of Aviation'. It features various images of aircraft, a person at a computer, and a network diagram. Text elements include 'Revolutionary Vehicles', 'On Demand Mobility', 'Educated Workforce', 'The Aeronautics Blueprint', 'National Security', and 'A National Imperative'. A timeline at the top shows years from 2002 to 2020. A red box at the bottom contains the text: 'The cost of inaction is gridlock, constrained mobility, unrealized economic growth, and loss of U.S. aviation leadership.'

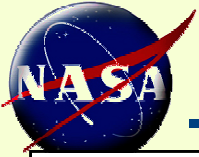
■ The cost of inaction is gridlock, constrained mobility, unrealized economic growth, and loss of U.S. aviation leadership.

Figure 3

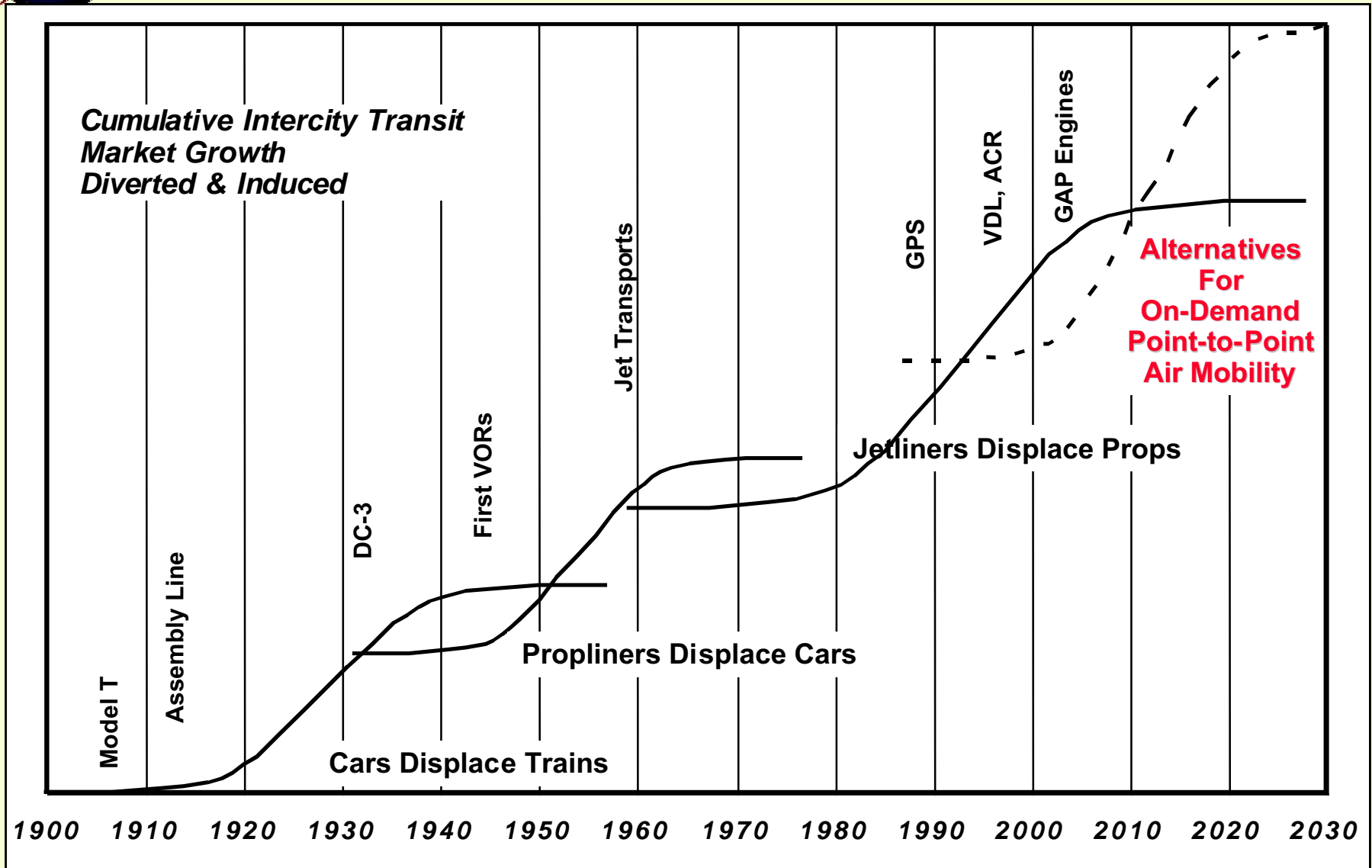


The Difficulty About Predictions...

- **“The telephone has too many shortcomings to be seriously considered as a means of communication.”**
– Western Union executive, 1876
- **“The problem with television is that the people must sit and keep their eyes glued on a screen; the average American family hasn’t time for it.”**
– NY Times, 1939 (World’s Fair)
- **“I think there is a world market for maybe five computers.”**
– IBM Chairman Thomas Watson, 1943
- **“Computers in the future may weigh no more than 1.5 tons.”**
– Popular Mechanics, 1949
- **“There is no reason for individuals to have a computer in their home.”**
- DEC Chairman Ken Olson (DEC), 1977
- **“640,000 bytes of memory ought to be enough for anybody.”**
– Microsoft Chief Software Architect Bill Gates, 1981

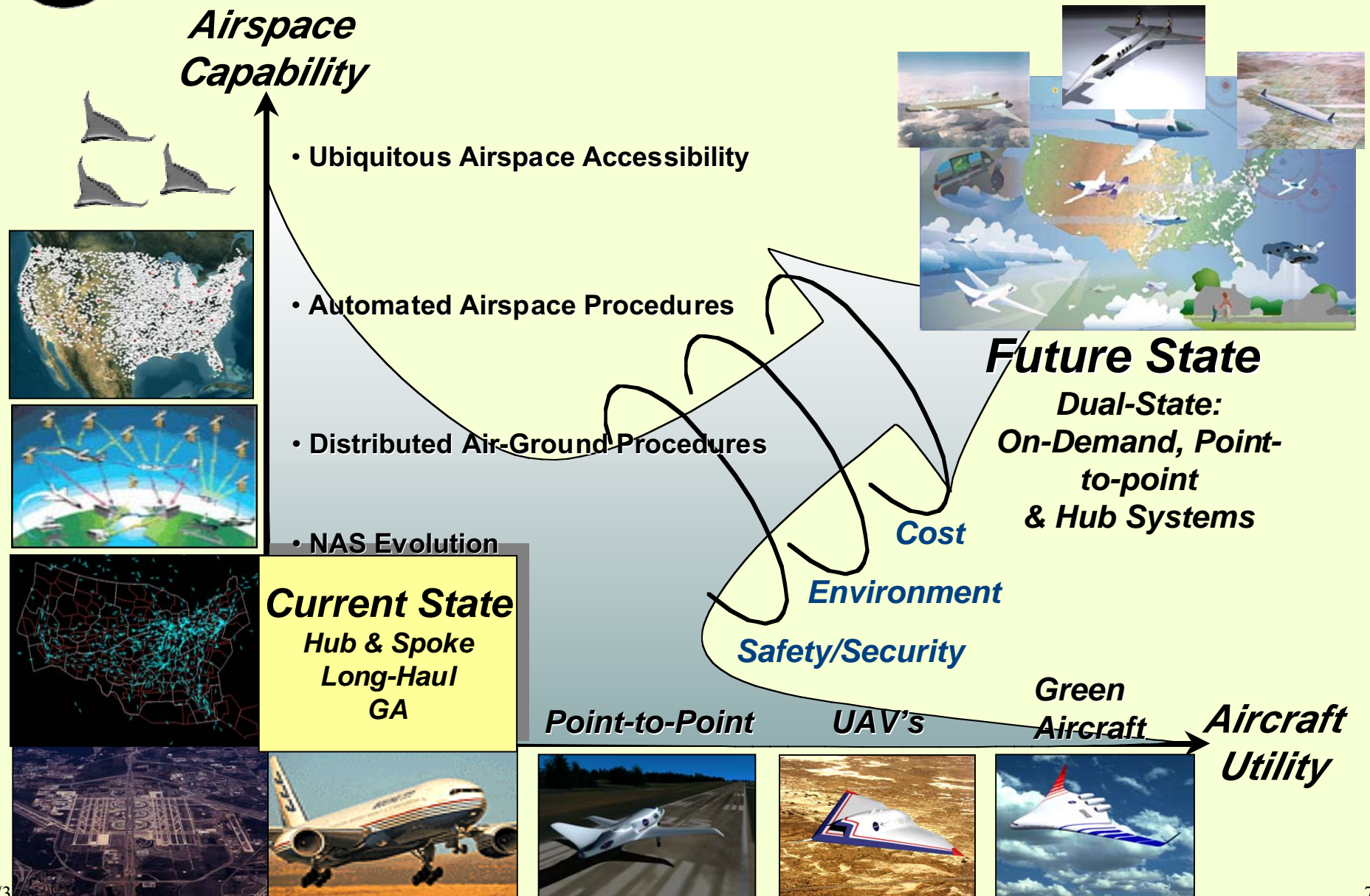


Notional Life Cycles in Higher-Speed, Longer-Range Daily Travel



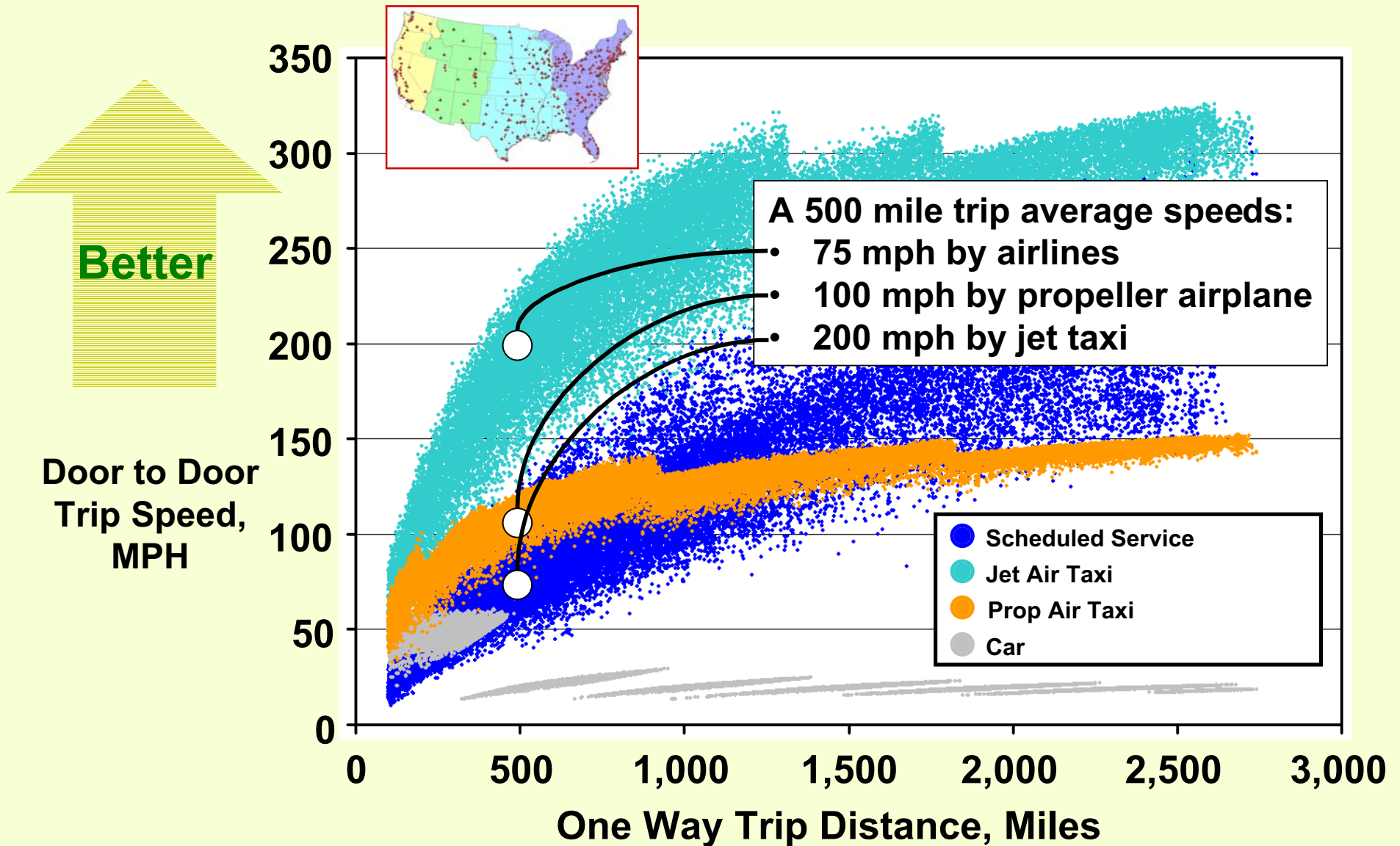


Integrated Advancements In Airspace and Aircraft

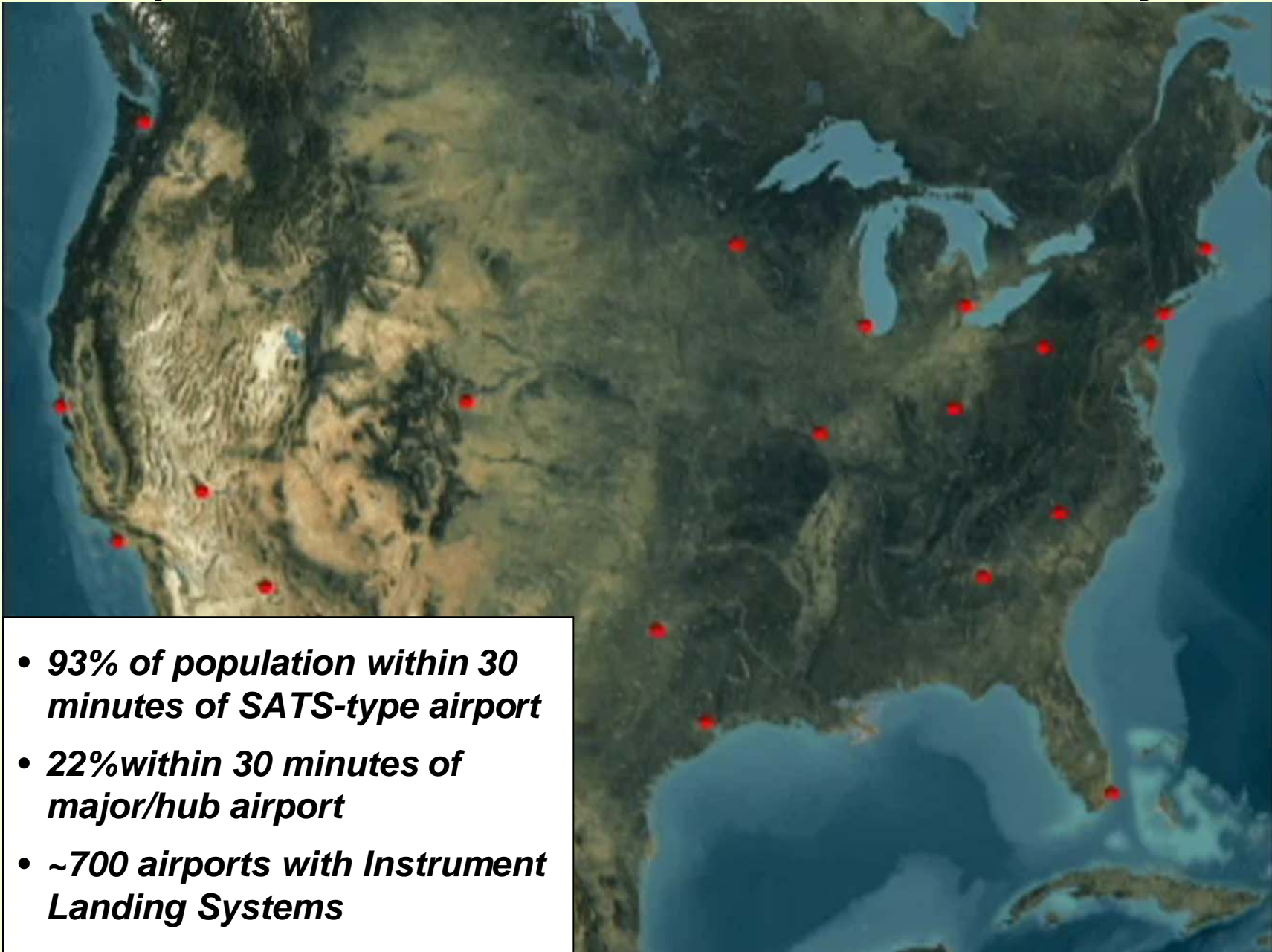




If Time is Gold *Then Door-to-Door Speed is the Coin of the Realm*



Equitable, On-Demand, Distributed Air Mobility





Public-Private Consortium Membership



NATIONAL CONSORTIUM FOR AVIATION MOBILITY (NCAM)



FAA Roles

AVR-SATS Team on Certification Issues

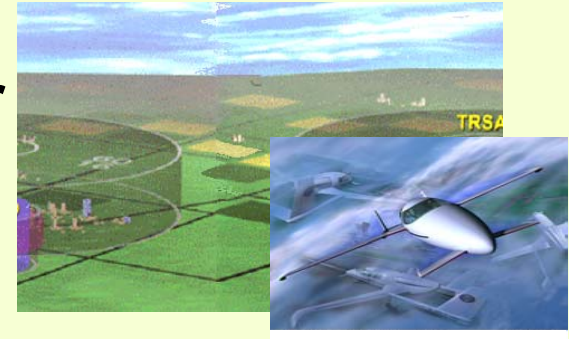
- **Aircraft Certification**
- **Flight Standards Services**
- **Provide consultation to SATS on airworthiness certification policies, processes and operations**
- **Recommend FAA policy development necessary for new technology applications**
- **Facilitate certification of SATS deliverables within AVR organization and procedures**
- **Operational approvals for SATS demonstration flights.**



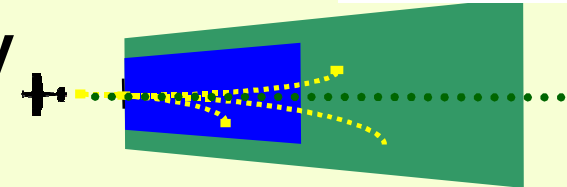
Small Aircraft Transportation System Project

Operating Capabilities for Access to All Communities/

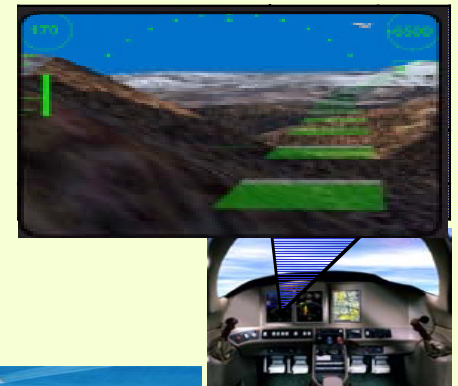
**Higher Volume Operations in Non-Radar
Airspace and at Non-Towered Airports**



**Lower Landing Minimums at Minimally
Equipped Landing Facilities**

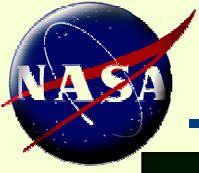


**Increase Single-Pilot Crew Safety &
Mission Reliability**

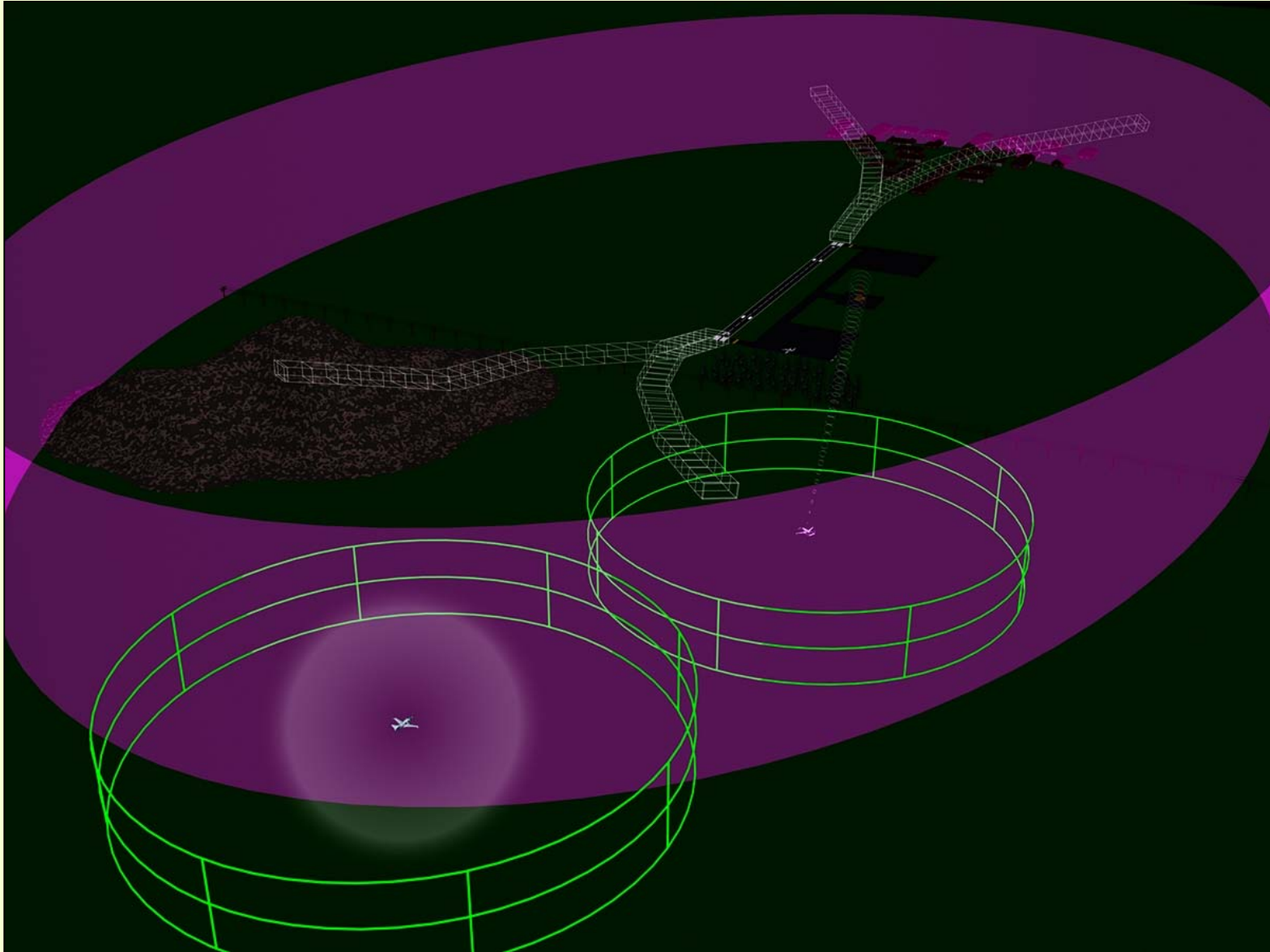


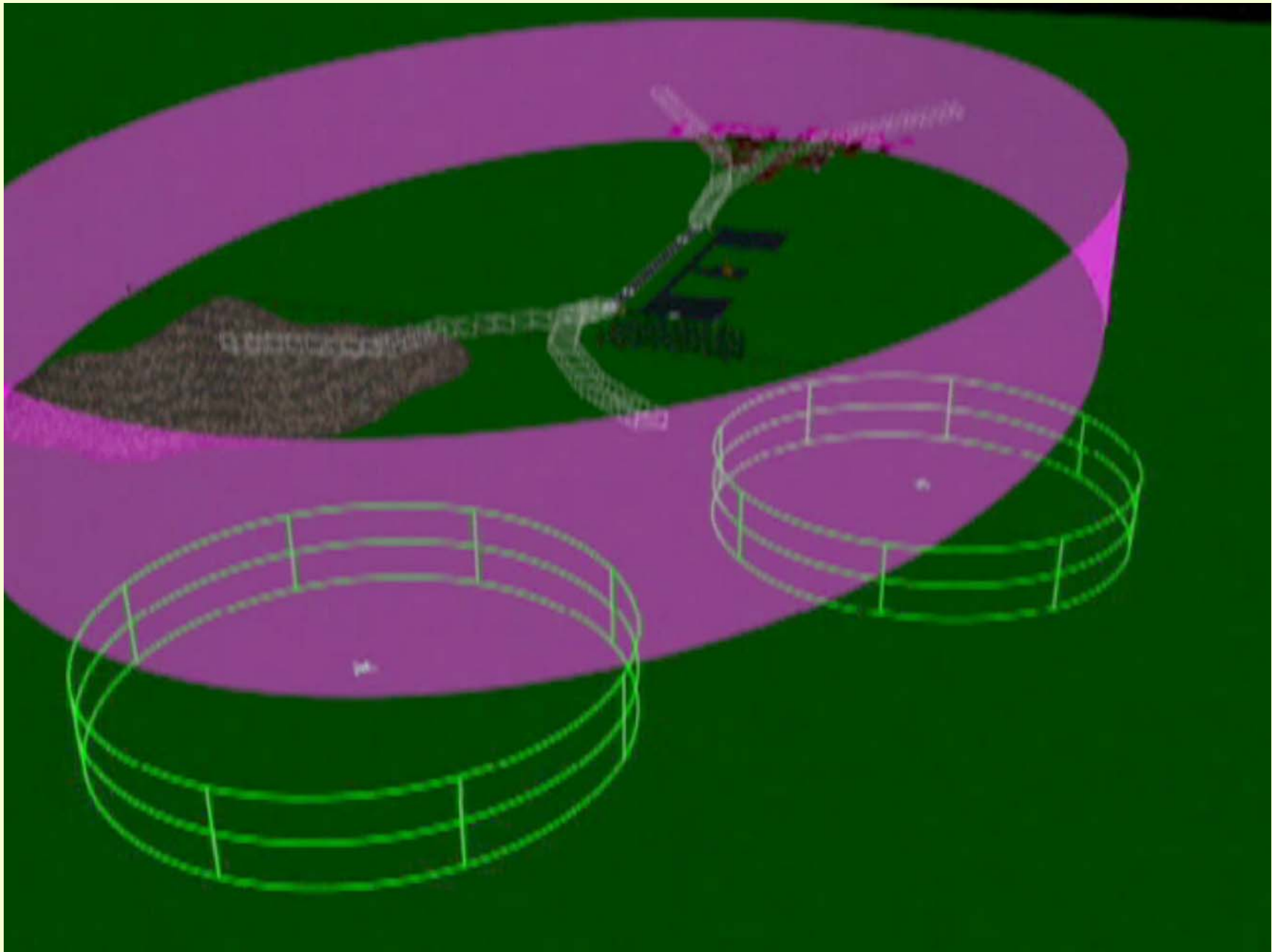
**En Route Procedures & Systems for
Integrated Fleet Operations**





SATS Operating Capabilities

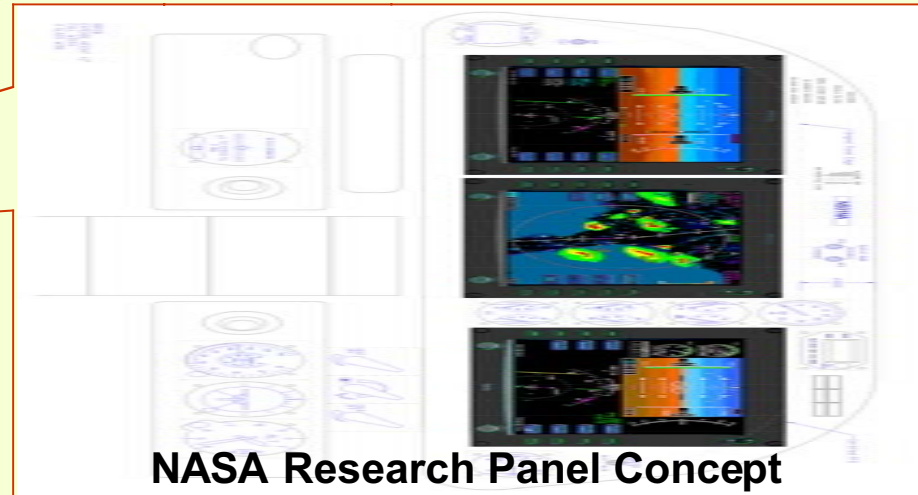






SATS Research Aircraft

NASA 501 Cirrus SR-22X



- **Digital, all-electric cockpit system architecture**
 - Dual avionics computer resources, databus, reversionary displays, and redundant power sources
 - Fully integrated IFR primary flight display (PFD) and multi-function display (MFD)
 - Digital radios / datalink for ADS-B, FIS-B, CPDLC, D-ATIS, AMM-Comm
 - GPS / DGPS / RNP RNAV
 - Synthetic vision-based terrain & obstacle graphics
 - Intuitive flight path guidance
- **Research Software Development**
 - Self-Separation: Conflict Alerting and Conflict Prevention Graphics (ASI, VSI, Nav-Hdg)
 - Sequencing software and graphics (Requested Time of Arrival - RTA waypoints)
 - Self-Controlled Airspace “Rules of the Road”



Airborne Internet Preliminary Demonstration

Accomplishment

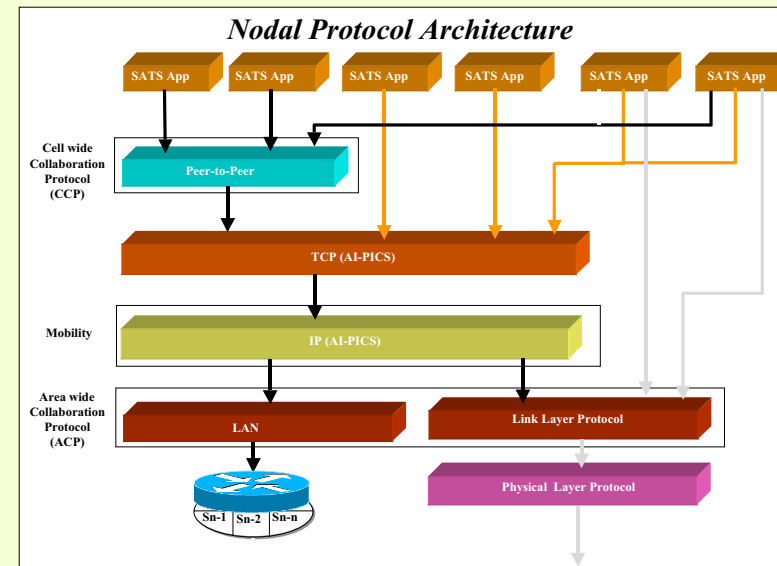
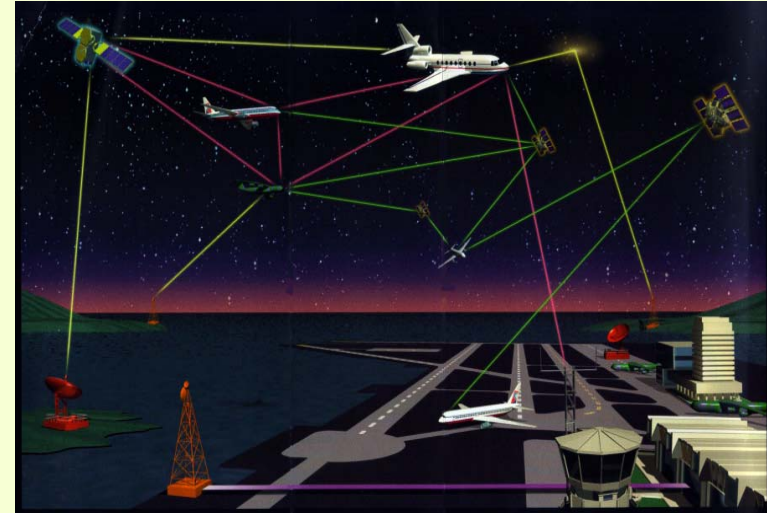
Demonstrated integrated communications, navigation, and surveillance architecture in lab testbed

Benefits

- Mobile and policy-based routing
- Service priority communications
- Secure network communications
- Point-to-point, point-to-multipoint, and broadcast addressing
- Based on open standards and protocols.
- Minimizes number of radios and antennas on an aircraft—goal is single radio for all data communications

Plans

- Evaluate candidate communication architectures
- Plan flight evaluations in 2005
- Airborne Internet Consortium Development



GLENN RESEARCH CENTER



A Revolution in the Cost of Speed

Toyota

Honda

Diamond



Adam Aircraft



Cessna Mustang



Safirre



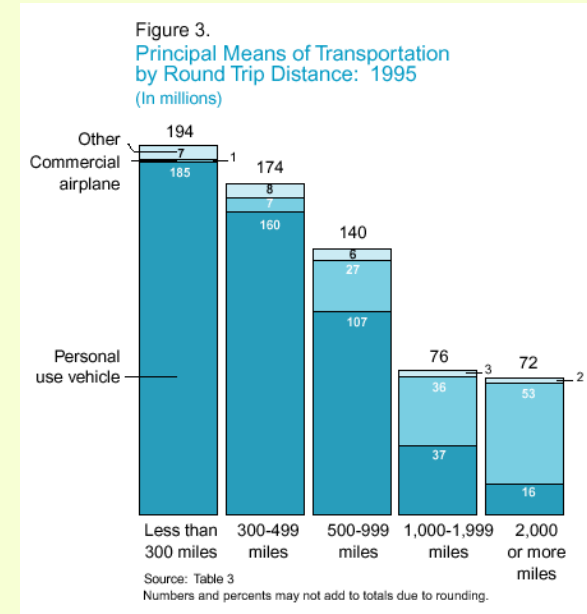
Eclipse



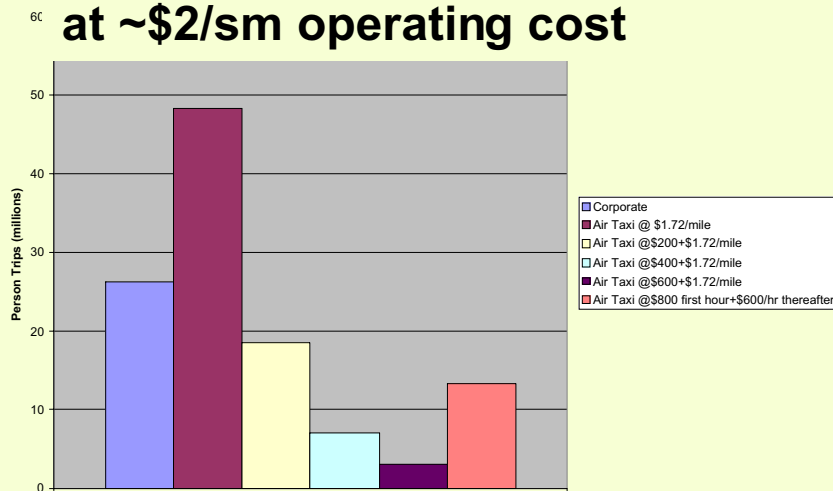


Future Aircraft Market Demand and Sensitivity Assessments

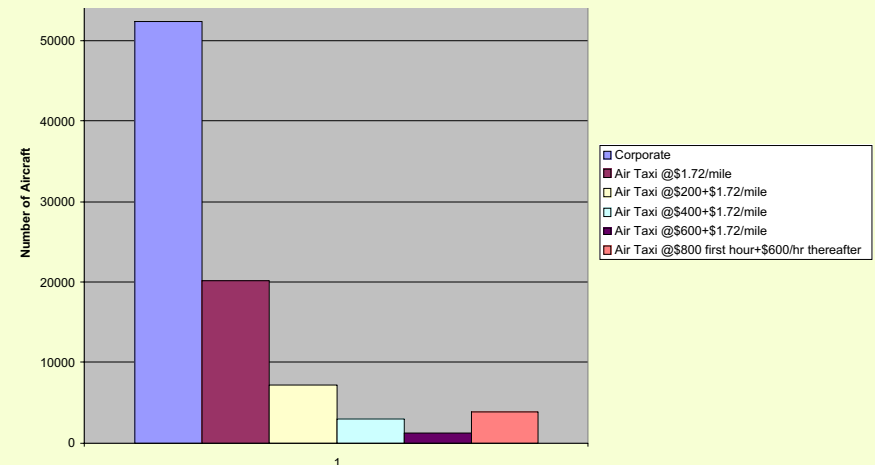
- **Data Source - 1995 American Travel Survey + 2000 US Census**
- **Tools - Modified Integrated Air Transportation System Evaluation Tool (IATSET)**
- **Approach - The IATSET is a macro economic model and predicts at a National level the mode choice between automobile, scheduled air, and on-demand air travel based on the value of a traveler's time and the monetary cost of the trip**
NASA CR 2002-211927.



**Between 13 and 47 million trips
at ~\$2/sm operating cost**

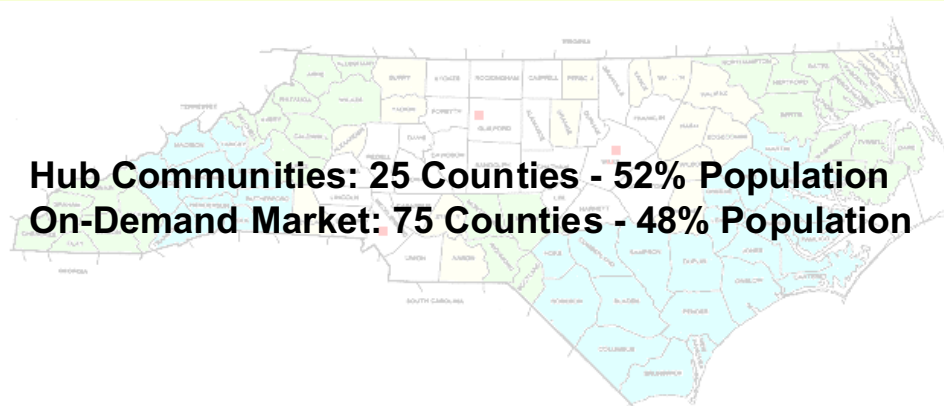


**Between 7,000 and 52,000 aircraft
required to serve new markets**





North Carolina Market Assessment for On-Demand Business Travel



Assumptions

- Business Travel
- 98% Accommodation @ ≤ 3 hours
- 175 fleet of Eclipse/Safire/Adam-class Jets
- \$1.85 per passenger ticket mile
- No weather impacts

Findings

- Case Study Analyses + Business Case Analyses + Assumptions = **425 passengers/day demand at \$1.85 per passenger-seat mile**
- Demand highest in communities most remote from commercial air service
- Air-taxi service best meets needs of surveyed likely business travelers
- Increased passenger volume allows higher profit margins and/or lower ticket prices and shorter accommodation intervals
- Advanced technology significantly reduces required ticket price

* Ignores potential passenger demand from “hub communities”, ignores passenger travel originating external to NC, ignores leisure and vacation travel demand, uses simplified dispatch strategy with no “optimization”



What Challenges Lie Ahead?

Vehicle Systems: A further revolution in the cost of vehicle speed is needed for:

- Shorter range, intra-urban, multi-point distributed mission (<100 miles)
- Mid-range, inter-city point-to-point missions (100-1,000 miles)
- Longer range (>2000 mile) high-speed point-to-point missions

Airspace Systems: A further revolution in airborne and airspace technologies and procedures automation for reliable ubiquitous accessibility:

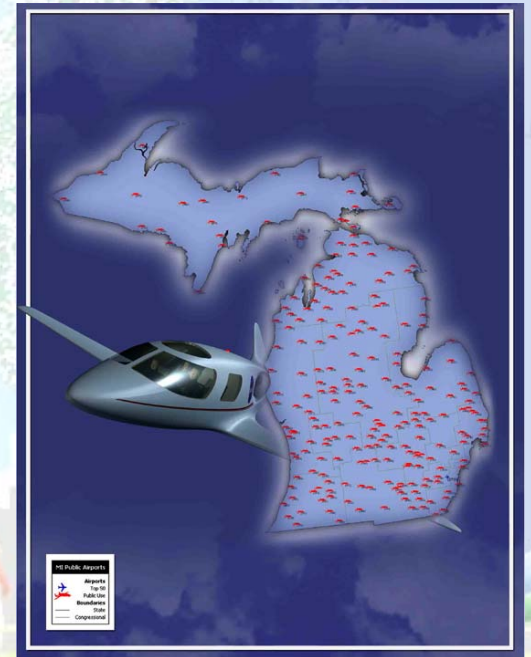
- Intuitive display systems
- Intuitive control systems
- Intuitive NAS procedures





Summary

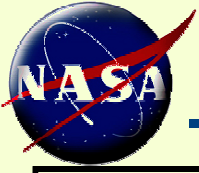
- **Studies reveal the cost and service thresholds for on-demand, widely distributed air travel alternatives to hub-and-spoke and highway travel may be reached with new generation aircraft and airspace technologies.**
- **While we cannot know exactly what forms of travel services consumers will see, NASA's aviation technology strategies assume a "dual state" for 21st Century air travel:
On-demand distributed + hubbing services**
- **The effects on airports include:**
 - **New operational capabilities at more runway ends**
 - **Alternatives to traditional terrestrial communication, navigation, and surveillance systems**
 - **Increased demand for information-technology services**
 - **Potential for increased operations at smaller airports in the longer-term**



**From Wheels on America
to Wings on America**



**Equitable
On-Demand
Widely Distributed
Point-to-Any Point
21st Century Air Mobility**



SATSLab Members/Stakeholder Participation

	Southeast SATSLab Consortium, Inc.	Maryland Mid-Atlantic SATSLab	North Carolina & Upper Great Plains SATSLab	Virginia SATSLab Inc.
Government	<i>FL DOT</i>	<i>MD Aviation Administration DE State Aviation Administration NJ State Aviation NAVAIR Warfare Center, Aircraft Division</i>	<i>State Aviation Authorities - NC, OK, NE, KS, ND, SD</i>	<i>VA Dept. of Aviation 5th Congressional District</i>
Industry	<i>AGILIS, Avidyne, Avrotec, Cogent Corp. Intl., Engineering & Computer Simulations, Goodrich Corp., GNSS, Harris Corp., Jakari Assoc., Jeppesen, Jetson, LOGO, PROTON, Rannoch, Raytheon, Rockwell-Collins, Safire, Seagull Technologies, SMA, Teamvision, TPSI</i>	<i>UPS Aviation Technologies SAIC, ASI, ARINC Applied Systems Decision Studies Inc. Cirrus Design Corp, Lancair Corp Kollsman, Inc, Ed Spring and Associates</i>	<i>RTI UPS Aviation Technologies Rannoch Nav3D MITRE</i>	<i>Avidyne Corporation Airborne Internet Airframe Corp (TBD)</i>
Service Operators	<i>Air Traffic Consulting Service Flightline</i>	<i>Airpark Sales & Services Hinson Corporate Flight</i>	<i>Telford Aviation, Piedmont Hawthorne Aviation, United Airlines, Atlantic Aero, Flight International</i>	
Airports	<i>Daytona Beach, Gainesville, Hernando County, Melbourne, Sebring, Tallahassee Commercial & Regional, Tamiami, Titusville- Cocoa</i>		<i>{Dare County, Northeastern, Warren, Rocky Mount-Wilson, Andrews-Murphy}, NC Oklahoma Centennial, OK</i>	<i>Danville</i>
Academia/ Universities	<i>Embry-Riddle Aeronautical U. Georgia Tech Research Institute Ohio State U. U. of Tennessee</i>	<i>Maryland Advanced Development Laboratory Glenn L. Martin Wind Tunnel, U. of MD</i>	<i>U. of Nebraska-Omaha U. of Kansas Langston U.</i>	<i>Virginia Tech Averett U. Old Dominion U.</i>